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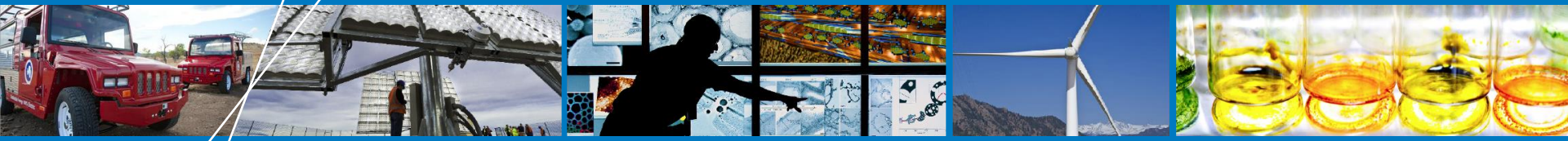
Repowering Wind Plants: Decisions and Drivers



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CEC Staff Workshop: Workshop for Identifying Challenges and Effective R&D Paths for Promoting Repowering Wind Energy

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Sacramento, California

Background

- **Repowering can be defined in two ways:**
  - Full repowering: complete dismantling and replacement of turbine equipment at an existing project site
  - Partial repowering: replacing selected turbine or plant components to extend the life of a given facility at some cost that is less than full repowering; may also trigger fewer legal hurdles

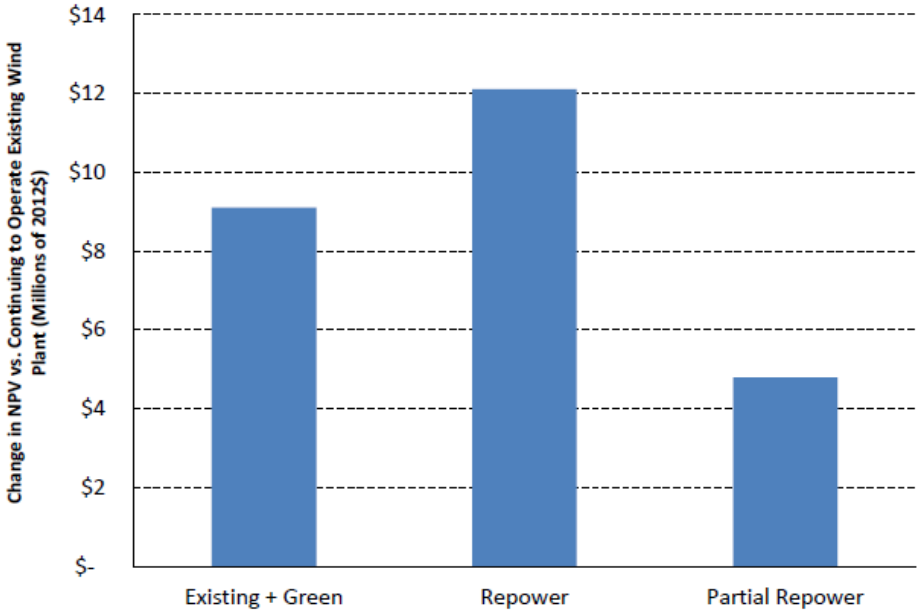
- **Repowering offers various opportunities:**
  - Increased project productivity
  - Better utilization of high-value resource areas
  - Improved grid support and interactions
  - Reduced visual impacts (fewer turbines per overall capacity)
  - Potentially reduced avian and wildlife impacts

- **Repowering first emerged in the early 1990s in the California and Danish wind power markets and was followed by the Dutch and German markets in the 1990s and 2000s.**

U.S. Case Study

- **Projects that "operate in the black" have little incentive to repower, relative to investing in new greenfield sites**
- **Around 20-25 years of operation, the choice between investing in greenfield sites and repowering becomes viable but depends on:**
  - Cost and performance of new technology
  - Anticipated energy production of comparable greenfield site
  - Durability and reliability of turbine equipment
  - Usefulness of existing infrastructure
  - Wholesale market electricity prices and existing contractual arrangements
- **Partial repowering solutions that can be realized at a lower cost would likely prove more viable**
  - Analysis of partial repowering assumes:
    - An increase in net capacity factor (NCF) from 30% to 37%
    - A 15% cost reduction relative to a green field (~10% relative to repowering).

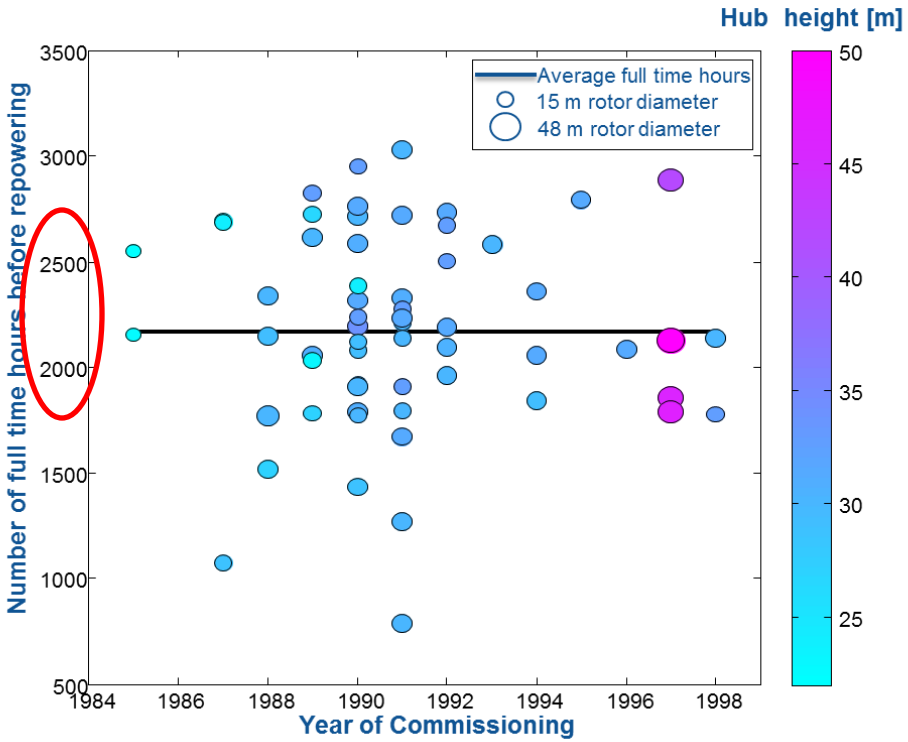
Cash Flow Analysis of 2003 Vintage Wind Plant in 2025



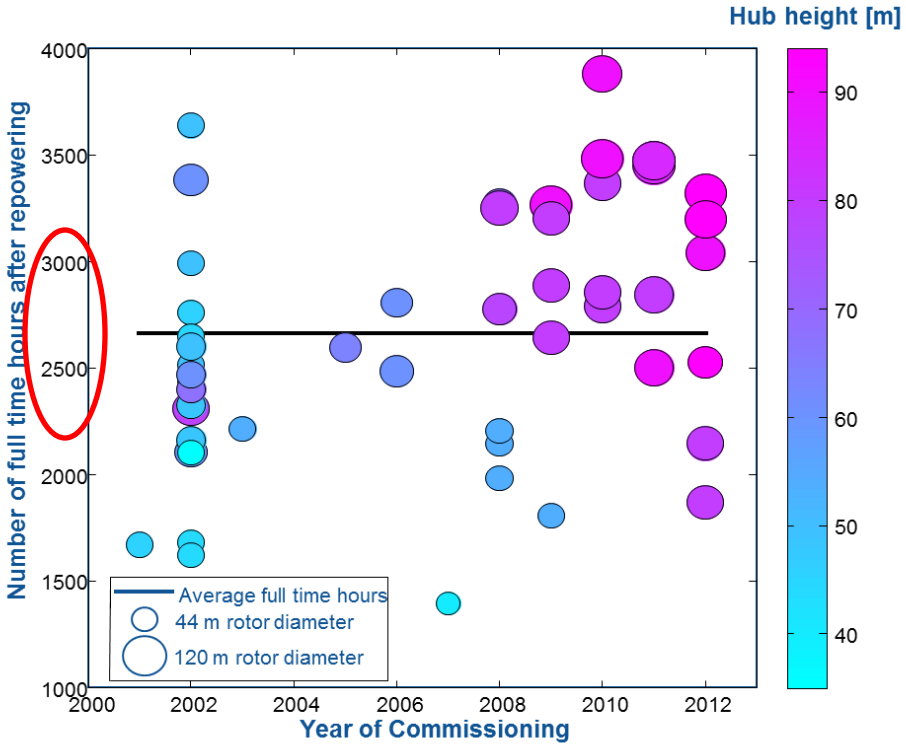
Source: Lantz et al. 2013. Note: data in the figure illustrate value gained or lost as a result of a specific investment decision; as each of these plants is modeled at an equivalent size, the change in plant-specific net present value can be compared across time; however, caution is advised against any direct assessment of wind plant profitability or return on investment, as the overall magnitude of net present value is highly correlated to plant size

European Experience

Before Repowering



After Repowering



Note different scales.

Source: Buzau et al. (forthcoming)

- Repowered wind plants have an increased hub height (2X), rotor diameter (3X), and rated capacity (5X), resulting in increased productivity. For example, the number of average full time hours has increased about 20%.
- The figures show an analysis of 48 wind plants in Denmark installed in the 1990s and repowered in the 2000s.

Research and Development Opportunities

- **To what extent can existing infrastructure be used to support taller towers, larger rotors, and/or improved site layout to increase project productivity?**
  - Could innovative drive-system and/or blade designs make partial repowering financially attractive?
- **How will unused materials be recycled or repurposed?**
- **Would improved energy capture at high-value resource areas enable California to meet carbon emission reduction goals more cost effectively than development of greenfield sites or importing electricity from other states?**
- **What technology innovations are needed to improve grid support? And would enhanced grid services from repowered wind projects affect California system reliability or transmission expansion requirements more generally?**
- **Would visual impacts be reduced?**
- **Would avian and wildlife impacts be reduced?**

Sources and Contact Information

- Lantz, E., M. Leventhal, I. Baring-Gould. 2013. *Wind Power Project Repowering: Financial Feasibility, Decision Drivers, and Supply Chain Effects* (Technical Report). TP-6A20-60535. National Renewable Energy Laboratory (NREL), Golden, CO (US). http://www.nrel.gov/docs/fy14osti/60535.pdf
- Buzau, M., Serrano-Gonzalez, J., Lacal-Arántegui, R. (forthcoming). Wind farm repowering: an analysis of wind farm performance. Ongoing work, Joint Research Centre of the European Commission.

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